1925.

CORTICIUM-DISEASE OF POTATOES.

EXPERIMENTS IN CONTROL.

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CORTICIUM-DISEASE, caused by the fungus *Corticium vagum* Berk. *et* Curt., var. *Solani* Burt, is a widespread disease of the potato, for it has been recorded as occurring wherever the host is grown. During a recent plant-disease survey made by Mr. J. C. Neill, of this Laboratory, through the potato-growing regions of New Zealand it was invariably found to be present; and in the South Island it was found to be abundant in every line of potatoes inspected. Although so widespread, it is a disease that is commonly overlooked, due no doubt to the fact that its effects upon the host are not marked.

When the crop is being lifted the disease may be seen in the form of small black sclerotia scattered over the surface of the tuber (Fig. 1). These sclerotia are resting bodies of the causal organism, capable of remaining in a quiescent condition for an indefinite period. They are firmly attached to the tubers by means of hyphæ, and are not readily removed, consequently they accompany the tubers when the latter are planted. In the presence of moisture, such as is present in the soil, the sclerotia produce hyphæ which ramify through the soil in the vicinity of the tubers, and spread to the potato-shoots as they develop. These hyphæ would appear frequently to damage the growing points of the main shoots, with the result that secondary shoots are produced from below the injured portions. In this manner affected tubers may give rise to bunches of small and spindly shoots, which, being weakened, produce small and stunted plants; these in turn produce few and small tubers. Thus infection, when severe, may tend greatly to reduce the yield.

In the literature dealing with this disease the standard treatment recommended (1, 3, 4, 5, 6, 8),* which has been claimed to give complete control (100 per cent. killing of sclerotia), is the immersion of infected tubers in a solution of mercuric chloride (corrosive sublimate, $HgCl_2$) in water—1 part in 1,000 parts of water, or 1 part in 2,000—for one and a half or two hours. More recently it has been claimed (2)* that immersion for half an hour is sufficient to ensure death of all sclerotia.

A potato-grower in Otago this season treated the whole of his seed-tubers before sowing by immersion for one hour and a half in 1–1,000 mercuric chloride. After treatment he forwarded samples to this Laboratory to ascertain whether the treatment had been successful. Sclerotia from these tubers were plated out on suitable media, and 30 per cent. were found to be viable. This led to preliminary experiments being carried out in the Laboratory with a view to ascertaining whether the standard solutions recommended were at fault. These experiments were unsatisfactory in that a proportion of sclerotia treated were found to be viable. Therefore an elaborate series of experiments was undertaken with a view to definitely ascertaining the most

* References at end of this article.

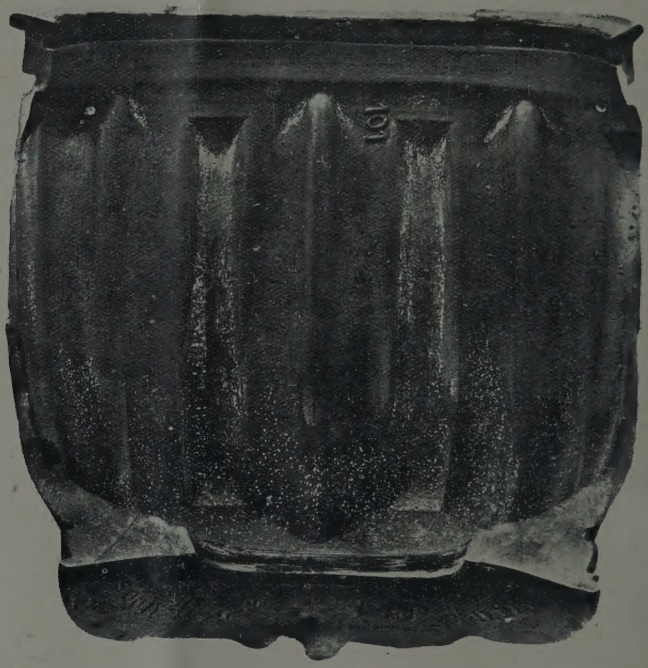


FIG. 9. A GROOVED HARD TEAT-CUP INFLATION AFTER TWELVE MONTHS' USE AND CLEANING BY THE SAME METHOD. CAPABLE OF THREE MONTHS' FURTHER USE.

[All photos by H. Drake.

(8.) Next disconnect the releaser, wash, rinse, and place in a clean, dry, sunny place; then disconnect the top or bottom half of the vacuum-tank and treat in a similar manner.

To ensure effective cleaning by this method it is essential that it be carried out daily in the manner directed. The caustic-soda solution instantly removes the greasy coating left by the milk on the inner surface of the tubing, and the final flushing with boiling water ensures the removal of the caustic-soda solution. In a short time the inner surface of the rubbers, through the action of the caustic soda, will become coated with a hard glass-like surface. If, however, the method is not carried out daily in the manner directed the grease will penetrate into the rubber, and it will then be necessary to revert to the use of spiral brushes, which in turn will damage the inner surface, as indicated in the accompanying illustrations.

The photographs are of rubbers which have been in actual use and subjected to different methods of cleaning. These serve to demonstrate the good results obtainable by the use of the caustic-soda-and-boiling-water method of cleaning.

efficient steep to be used, its strength, and the most suitable time of immersion (one hour and a half being considered much too long for farm practice).

In the following experiments tubers showing well-developed sclerotia were chosen. They were washed free from adhering earth and allowed to dry. The solutions were prepared in large glass vessels, and the tubers immersed for definite periods of time, then removed, labelled, and air-dried. Three tubers were considered sufficient for each phase of the experiment, and from each five sclerotia were removed and transferred to petri dishes containing certain culture-media—the most suitable being potato-dextrose-agar, which gave 100 per cent. of growth in controls. Each petri dish, by means of grease-pencil markings on the bottom, was divided into three sectors, and in each sector five sclerotia were placed. In this manner economy of media and petri dishes was obtained.

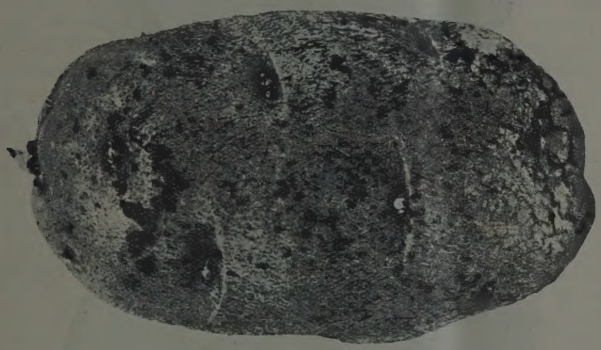


FIG. 1. POTATO TUBER COVERED WITH SCLEROTIA OF CORTICIUM-DISEASE. TWO-THIRDS NATURAL SIZE.

[*Photo by H. Drake.*

During the course of each experiment cultures were examined every twenty-four hours for five days, the final examination being made under the dissecting microscope. The cultures were then discarded, for it was found that if treated sclerotia made no growth before the third day they would not grow at all.

MERCURIC CHLORIDE ($HgCl_2$).

The first series of laboratory experiments was undertaken with a view to determining whether the mercuric solutions recommended would really kill sclerotia, and with the additional object of cutting down the time of immersion. The following strengths of solutions and times of immersion were used:—

Mercuric chloride—1–500, 1–750, 1–1,000, 1–1,250, 1–2,000, 1–2,500.
Times of immersion—15, 30, 45, 60, and 90 minutes.

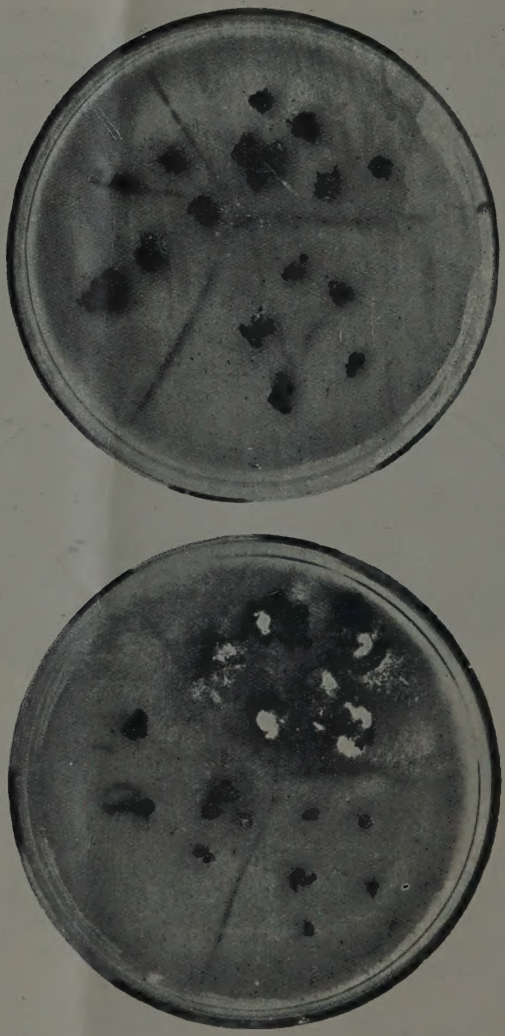


FIG. 2. SCLEROTIA OF CORTICIUM-DISEASE ON CULTURE-MEDIA.

(*a*) No growth—100 per cent. control; (*b*) partial control. The tubers from which these sclerotia were obtained had been soaked for ninety minutes in a 1–1,000 mercuric-chloride solution.

Photo by H. Drake.

The accompanying Graph 1 shows the results obtained from this experiment. In this and successive graphs the ordinate (vertical lines) show growth of sclerotia, the cipher O representing no growth or total killing, indicating that complete control has been attained; whereas the abscissæ (horizontal lines) represent strengths of the solutions used (unless otherwise stated). The series of curves given represent different times (in minutes) of immersion, acidity of solution, or strength of solutions. From Graph 1 it will be seen that the usual strengths of mercuric chloride recommended (1–1,000 or 1–2,000) do not give favourable results, for total killing is not obtained.

It was considered possible that the erratic nature of the curves obtained resulted from the frequent presence upon the sclerotia of air-bubbles, for it was noted at the time that these often persisted throughout the duration of the experiment. Therefore a second series of experiments was undertaken, in which the same strengths of solutions were used, and the tubers immersed for the same periods of time; but in addition the tubers were first presoaked for sixteen hours in tap water, it being considered that long immersion would tend to dispel the air-bubbles, and, permitting of the ready penetration of the mercuric-chloride solutions, tend to flatten the resultant curves. The time (sixteen hours) was merely an arbitrary one, being chosen for the reason that it would be most convenient to the farmer, who would require merely to place his tubers in water in the evening and have them ready for treatment in the morning.

In Graph 2 are shown the results obtained—results which are unsatisfactory both in point of time and killing, for it will be noted that, even after immersion for ninety minutes, solutions of a greater dilution than 1–750 do not give complete killing.

The latter experiment showed that lack of control was not due to imperfect penetration through interference by air-bubbles, so it was considered that greater concentration of solution might give satisfactory results. Therefore a further series of experiments was undertaken, in which tubers were immersed in various solutions for different times as follows:—

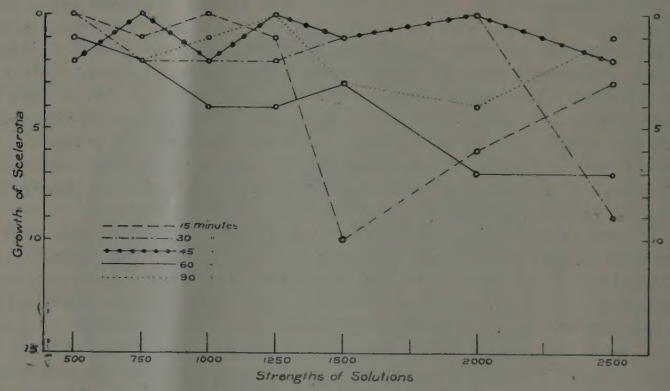
Third experiment—No presoak.
Fourth experiment—Presoak sixteen hours.
Solutions—Mercuric chloride, 1–200, 1–300, 1–400, 1–500, 1–750, 1–1,000.
Times of immersion—15, 30, 45, 60, 90, 130 minutes.

Results obtained showed that in Experiment 4 complete killing was obtained with solutions 1–200 to 1–500 (or 1–200 to 1–400 in Experiment 3) after immersion for two hours, but solutions weaker than this failed to give complete control. As the cost factor was considered to be such that solutions of 1–200 to 1–500 would be too expensive to use, a further series of experiments was undertaken in which solutions of Uspulun and copper sulphate were tried.

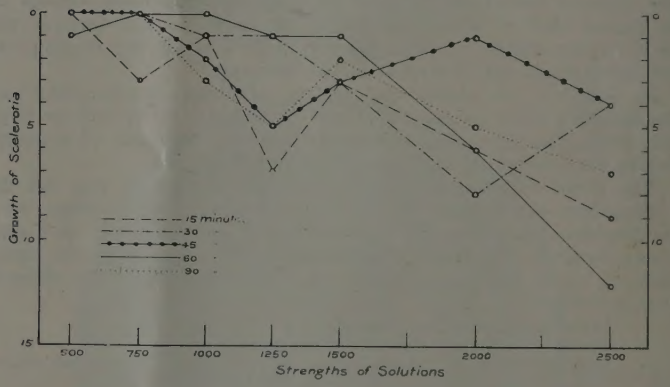
USPULUN.

This is a mercury-chloro-phenol compound, widely used to-day for the treatment of seed-wheat as a preventive of stinking-smut. In the experiment the following strengths of solution and times of immersion were used:—

Solution—1–400 (standard), 1–500, 1–600, 1–750, 1–1,000.
Times of immersion—15, 30, 45, 60, 90, 120 minutes.



GRAPH I. NO PRESOAK. MERCURIC-CHLORIDE TREATMENTS.



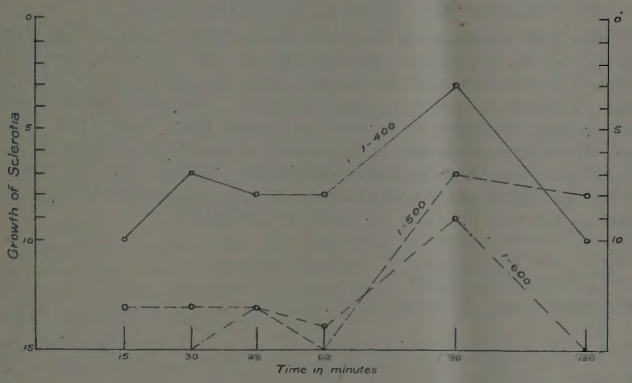
GRAPH 2. PRESOAK SIXTEEN HOURS. MERCURIC-CHLORIDE TREATMENTS.

These curves (time curves) show the effects of time of immersion and dilution of solutions on the killing of sclerotia.

Graph 3 (which differs from the preceding two in that the abscissæ give times of immersion in minutes and the curves strength of solution) shows that even after two hours' immersion 1–400 failed to give satisfactory control. Solutions 1–750 and 1–1,000 had no effect, for after two hours' immersion 100 per cent. growth was obtained from treated sclerotia.

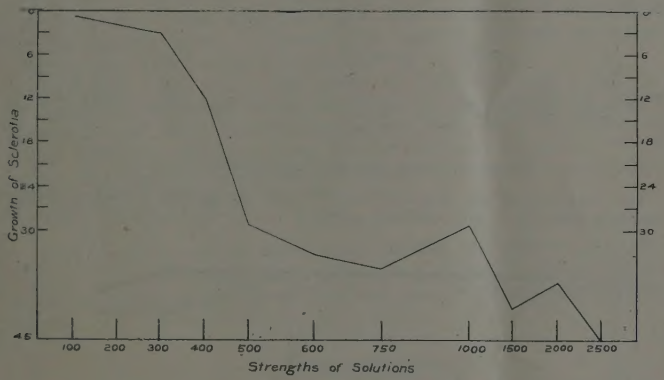
COPPER SULPHATE ($CuSO_4$).

Preliminary experiments with this fungicide gave every promise that it would prove a satisfactory if somewhat slower reagent than



GRAPH 3. "USPULUN" TREATMENTS.

These curves (solution curves) show the effects of different solutions on the growth of sclerotia. At no time is complete killing attained.



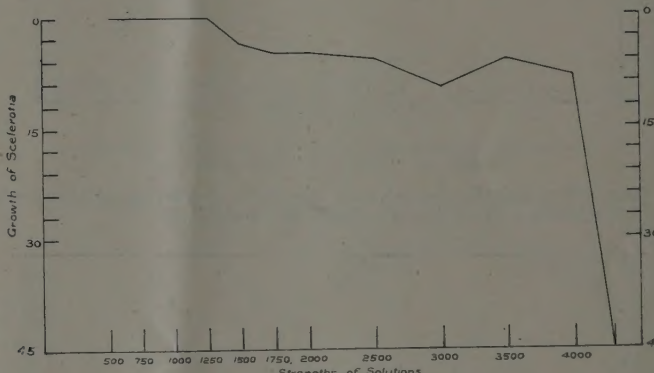
GRAPH 4. COPPER-SULPHATE TREATMENTS.

This curve shows the effect of sixteen hours' immersion in various solutions of copper sulphate.

mercuric chloride. Therefore a series of experiments was undertaken, in which tubers were immersed for sixteen hours in the following solutions: 1–100, 1–200, 1–300, 1–400, 1–500, 1–600, 1–750, 1–1,000, 1–1,500, 1–2,000. Graph 4 shows that even after this long immersion 1–100, the strongest solution used, would not completely kill all the sclerotia. In this last experiment nine tubers were used for each phase, instead of three as formerly. As these two compounds gave such unsatisfactory results, further experiments were undertaken with mercuric chloride.

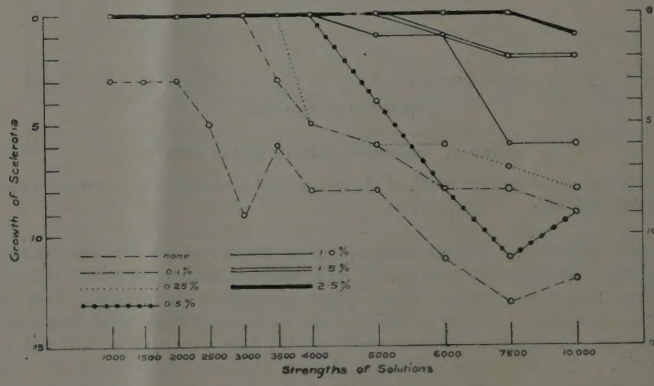
MERCURIC CHLORIDE (FURTHER SERIES).

In the next experiment (No. 17) tubers were immersed for sixteen hours (as in the previous experiment) at the following strengths: Mercuric chloride — 1–500, 1–750, 1–1,000, 1–1,250, 1–5,000, 1–1,750, 1–2,000, 1–2,500, 1–3,000, 1–3,500, 1–4,000. Graph 5 gives a curve of the results obtained. It will be noted that even after sixteen hours' immersion solutions of a weaker concentration than 1,–1,250 did not give complete killing, thus demonstrating forcibly the fact that one of the standard treatments widely recommended — namely, immersion for two hours in 1–2,000—is ineffective.



GRAPH 5. MERCURIC-CHLORIDE TREATMENTS.

This curve shows the effect of sixteen hours' immersion in various solutions of mercuric chloride. Only solutions 1–500 to 1–1,250 give complete killing.



GRAPH 6. ACIDIFIED MERCURIC-CHLORIDE TREATMENTS.

Each curve (save the first) represents a different percentage of acid added to the solutions. Time of immersion, 2 hours.

As the result of a chemical and physical study of mercuric-chloride solutions it was decided to determine the effect of acidity upon their killing properties. Preliminary experiments gave such promising results that a wide series was planned. In the next experiment (No. 21) strengths of mercuric-chloride solutions were used as follows: 1–1,000, 1–1,500, 1–2,000, 1–2,500, 1–3,000, 1–3,500, 1–4,000, 1–5,000, 1–6,000, 1–7,500, 1–10,000. Each solution was made up in seven vessels, and to each was added hydrochloric acid (commercial concentrated, 31·5 per cent.) at the following percentage strengths: None, 0·1 per cent., 0·25 per cent., 0·5 per cent., 1·0 per cent., 1·5 per cent., 2·5 per cent.

Concurrently with this was run another experiment (No. 20) to determine the effect of hydrochloric acid alone on the growth of sclerotia. Tubers, in lots of three, were immersed for two hours in vessels containing water to which the following percentages of acid had been added:—

HCl—*a*, none; *b*, 0·1; *c*, 0·25; *d*, 0·5; *e*, 1·0; *f*, 1·5; *g*, 2·5.

When the cultures were examined twenty-four hours later it was seen that all sclerotia from tubers immersed in solutions *a* to *e* respectively were alive, while ten (out of fifteen) in *f*, and none in *g*, had germinated. In forty-eight hours all the sclerotia in *f* and *g* had germinated. Thus even a 2·5 per cent. solution of hydrochloric acid has little effect upon sclerotia other than to retard their germination for twenty-four hours. Therefore it may be asserted that the acid alone has no effect upon the germination of sclerotia.

In Graph 6 are given the results of Experiment 21. Here it will be noted that although unacidified solutions do not kill at any of the strengths used, when as little as 0·1 per cent. of hydrochloric acid is added killing is obtained even at a strength of 1–3,000. It will be noted that there is a definite relationship between the amount of acid added and the killing of sclerotia.

Further experiments have been carried out with regard to this work. These will appear in a subsequent paper, in which also will be given the cheapest and most economic method of control of corticium-disease.

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(To be continued.)

WAX COATING OF CHEESE.

A RECENT TRIAL SHIPMENT.

W. E. GWILLIM, Assistant Director of the Dairy Division.

IT is a common practice in the United States to coat with paraffin-wax cheese required for the domestic trade. The method was first introduced as a preventive measure against cheese-flies and the undue growth of mould. Incidentally it was found that the flavour of the cheese held better, and there was less loss in weight due to shrinkage. Some experimental work was carried out here several years ago, and a trial shipment of wax-coated cheese was made to the British market, but the results achieved did not appear to be sufficient to encourage further effort.

The method is not universally approved by the trade in Britain. Some traders have a prejudice against wax-coated cheese, which is attributed to the idea that when such cheese is cut up into pieces and exposed for sale the loss in weight is greater than with cheese which has not been so treated. On the other hand, many traders prefer wax-coated cheese, and will buy it whenever opportunity offers, provided the quality is right. A considerable amount of trade is done each season in wax-coated Canadian cheese. The buyers appear to be those who thoroughly mature their cheese before sale.

In February last a trial was undertaken in co-operation with the Kiritaki Co-operative Dairy Company (Hawke's Bay) for the purpose of obtaining further data as to the acceptability of wax-coated cheese on the British market, and ascertaining to what extent the wax coating affected the quality of the cheese in regard to the flavour and body, and on the mould-growth and saving in loss of weight. A number of cheeses were taken from three vats each day for seven days, and, after having been on the shelves for about fourteen days, one half of the number from each vat were coated with wax and the other half left unwaxed. The cheeses were duly forwarded to the grading-stores and graded in the usual way. The score-points awarded for quality and finish were the same in each case—namely, 44½ for flavour, 28½ for body and texture, 15 for colour, and 5 for finish, making a total of 93 points. The cheeses were uncased and weighed to the nearest ounce. Two months later the cheeses were regraded and reweighed singly in London by our Inspector, Mr. W. Wright. He reported as follows:—

"No cracked lips are visible on the paraffined cheese, and it seems as though the paraffining would solve the problem of preventing the cracking of the lips of the cheese made in the type of hoop in general use. The cheese can be made very pleasing for the counter trade, as the mould-growth is easily removed with a cloth. The cheese have taken and are holding the wax very well indeed. On no cheese has there been any flaking-off or breaking-away of the wax from the bandage. Each cheese was judged separately for quality, and the points averaged out as follows: Waxed cheese (nineteen crates)—43·94 points for flavour, 28·25 points for body and texture, 14·94 points

is absorbed by the pith. Grass-straw does not split in this way, and consequently no amount of wetting would cause it to absorb any quantity of water.

In all we expected between 250 and 280 tons of farmyard manure, and we carted out about 180 tons. As already stated, operations were commenced in January, and the dung was ploughed under in June last, being applied at the rate of 60 to 70 loads, equivalent to 25 to 30 tons, per acre. Strips were left unmanured, the plan being to estimate the effect of the manure on the yield of mangolds. Results will be recorded later, after harvesting of the crop.

Whether this process will develop or not is entirely a matter of cost, and that aspect is being investigated. At present we are satisfied that the straw rots satisfactorily if the right conditions for bacterial growth are obtained.

CORTICIUM-DISEASE OF POTATOES.

EXPERIMENTS IN CONTROL.

(Concluded.)

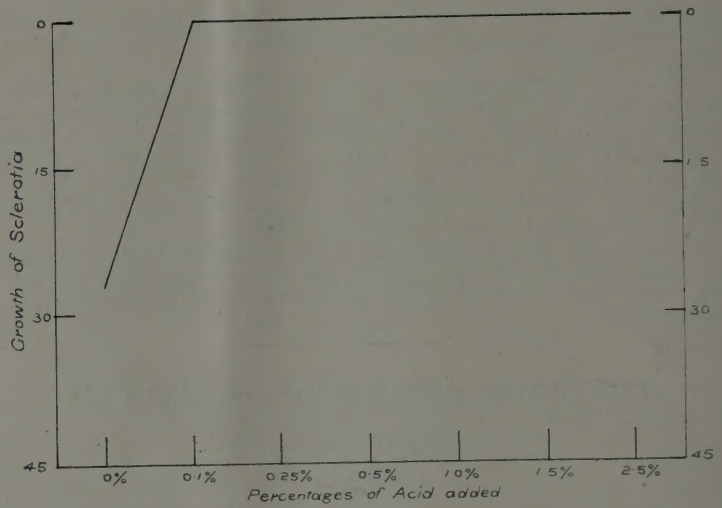
G. H. CUNNINGHAM, Mycologist, Biological Laboratory, Wellington.

IN a previous article (*Journal* for last month) it was shown that the standard treatments recommended for the control of corticium-disease, *Corticium vagum* var. *Solani* Burt, were not successful because they did not kill more than about 80 per cent. of the sclerotia present on the tubers treated. Numerous experiments were undertaken with a view to discovering some cheap and efficient means of killing these sclerotia, with the result that mercuric chloride, *when acidulated with hydrochloric acid*, was found completely to kill all sclerotia even at strengths much less than usually recommended.

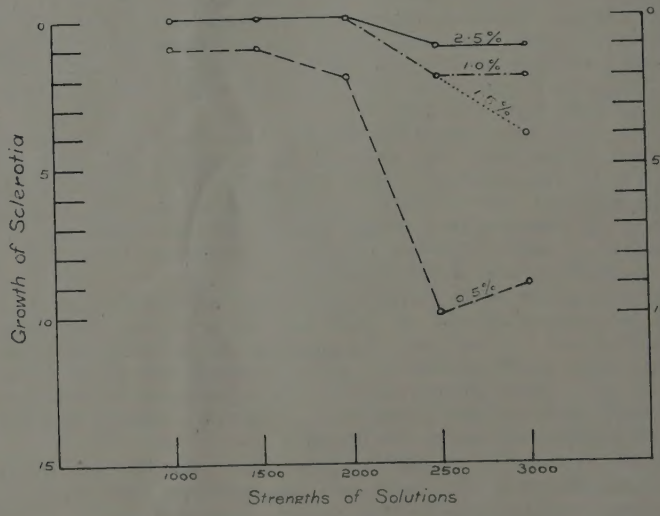
These experiments solved the problem in so far as the steep was concerned, so that there then remained the problem of cheapening the process in both material and labour. In regard to the latter factor, it is evident that a more practical method than the two-hour steep is necessary in dealing with the large quantity of seed tubers used by commercial growers. Therefore experiments were undertaken with a view to modifying the period of immersion.

For the smaller growers with a small quantity of seed to treat, it might be more practicable to place the tubers overnight in some suitable solution, to be ready for planting the following morning. Graph 7 shows that a solution of 1 part of mercuric chloride in 10,000 parts of water, when acidified with as little as 0·1 per cent. of hydrochloric acid, gives complete killing of all sclerotia, a result not obtained with an acid-free solution of this strength.

Further experiments were undertaken with a view to reducing the time of immersion to such an extent that treatment could be made a continuous process, thus making machine treatment feasible. The results finally obtained are shown in Graph 8. In this experiment tubers were immersed for five minutes in acidulated mercuric-chloride solutions of the following strengths: Mercuric chloride—1–1,000, 1–1,500, 1–2,000, 1–2,500, 1–3,000; hydrochloric acid—0·5 per cent., 1 per cent.,



GRAPH 7. SHOWING EFFECTS, AFTER SIXTEEN HOURS' IMMERSION, OF DIFFERENT PERCENTAGES OF ACID (HCL) ON THE KILLING-PROPERTIES OF 1—10,000 MERCURIC-CHLORIDE SOLUTIONS.



GRAPH 8. SHOWING EFFECTS, AFTER FIVE MINUTES' IMMERSION, OF DIFFERENT PERCENTAGES OF ACID WHEN ADDED TO SOLUTIONS OF MERCURIC CHLORIDE.

The curves represent percentage strengths of acid.

1·5 per cent., 2·5 per cent. After treatment the tubers were placed in a heap and covered with a sack wetted with 1–3,000 mercuric chloride. They were left overnight and the sclerotia plated out in the morning.

Graph 8 shows that this treatment resulted in the death of all sclerotia taken from those tubers which had been immersed in 1–1,000 and 1–1,500 solutions to which had been added 1, 1·5, and 2·5 per cent. of hydrochloric acid. This reduction in time required for treatment allows of the treatment of tubers in large quantities by the use of a mechanical device whereby tubers may be carried on a conveyer through the solution and transported to the drying-floor.

DIRECTIONS FOR TREATMENT.

Overnight Treatment.—Procure a wooden or concrete (not metal) tub or trough and fill with Solution A (see below). Place the tubers in this solution, being careful to have sufficient liquid present to cover all to a depth of at least 3 in. Leave the tubers in overnight, and in the morning remove and either immediately plant or dry and store until required. The time of immersion (sixteen hours) is merely an arbitrary one, as equal results will be obtained whether the tubers are left in the solution for twelve or twenty-four hours.

Five-minute Treatment.—Prepare solution in the same way as in the previous treatment, but use instead Solution B (see below). Leave in for at least five minutes (longer periods than this will have no detrimental effect upon the tubers) and remove to a floor, where the tubers should be piled in heaps and covered with sacking dipped in the same solution. Leave the heap covered for from sixteen to twenty-four hours, and either plant immediately or dry and store until required.

SOLUTIONS.

Solution A, Sixteen-hour Treatment.—Stock solution: Mercuric chloride, 50 grams (1¾ oz. approx.); hydrochloric acid (conc.), ½ litre (⅞ pint approx.). This quantity of stock solution contains sufficient to make 110 gallons of steep. For smaller quantities add 1 fluid ounce of the stock solution to 12 gallons of water.

Solution B, Five-minute Treatment.—Stock solution: Mercuric chloride, 200 grams (7 oz.); hydrochloric acid (conc.), 2 litres (3½ pints). This quantity of stock solution is sufficient to make 66 gallons of steep. For smaller quantities add 1 pint of stock solution to 19 gallons of water. After treatment with A the solution should be discarded; Solution B may be used three or four times before being discarded. As these solutions are corrosive and very poisonous they should be handled with care and kept away from children or stock. The use of metal implements should be avoided, as they will become corroded if allowed to come in contact with these solutions.

The mercuric chloride used should be of good quality, and the hydrochloric acid of commercial concentrated standard (31 per cent.). The cost of these substances is comparatively low, mercuric chloride being 6s. per pound, and hydrochloric acid 7s. 6d. per "winchester" of 10 lb. Thus the cost of the material required to prepare 66 gallons of Solution B is 7s. 8d., and that of Solution A 1s. 2d.

FUTURE WORK.

Further work is required to determine (1) the effects of treatments upon the tubers, and (2) the detrimental effects of the disease upon the yield. With regard to (1), it may be stated that all tubers were kept after treatment, and the production of shoots noted. In all cases where the tubers had well-developed shoots these were killed back to the tuber; but in the course of a few days further shoots developed in abundance, save in those cases where the solutions used had been acidified with 2·5 per cent. hydrochloric acid. With these, delay of a fortnight was evident, and with tubers which had been cut prior to immersion death was not infrequent. It is hoped next season to be able to carry out an extensive series of field experiments, with a view to solving these two last problems.

The writer is indebted to Mr. J. C. Neill, of this Laboratory, for assistance rendered during the course of the experiments.

CONCRETE-WORK ON THE FARM.

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THE advantages of concrete-structure on the farm are now generally recognized, but practical knowledge of the technique of the work is often lacking among farmers. In a series of articles—now commenced—the writer proposes to give sufficient detailed information to enable any handy man to undertake the simpler structures or operations. The present instalment deals (1) with the general subject of materials, and (2) with the making of concrete posts. In subsequent articles it is proposed to treat similarly some other uses to which concrete can be put on the farm.

1. MATERIALS AND THEIR PREPARATION.

The materials used in making concrete are the "aggregate," cement, and water.

The aggregate may be natural shingle, broken shingle, crushed rock, sand, or a combination of these. It should consist of well-graded material—that is, material of all sizes between the largest stones allowed and sand. The material most commonly used is pit, river-bed, or beach shingle, and great care must be taken that there is neither clay nor vegetable matter present. If the shingle contains any soil or plant debris it must be washed free of these. A convenient form of trough for this purpose is shown in Fig. 1. The aggregate is placed in the trough and stirred thoroughly while water is run through. The lighter clay or soil particles or vegetable matter are carried out at the overflow notch.

The maximum size of stones allowed in the aggregate will depend on the nature of the work. For ordinary fencing-posts and troughs the largest stones should pass through a $\frac{3}{4}$-in. mesh screen. For posts above 8 in. by 8 in. larger stones may be allowed, but should not be larger than will pass through a screen of $1\frac{1}{2}$ in. mesh. Floors and